What is claimed is:

1. A method of injecting a liquid volume into a microchannel, comprising
forming a droplet from the liquid; and
directing the droplet to a virtual wall formed by a first fluid in a fluid interface port formed in a sidewall of the microchannel.

2. The method of claim 1, further comprising the step of charging the droplet after forming the droplet.

3. The method of claim 2, wherein the step of directing comprises establishing an electrostatic field to guide the charged droplet to the virtual wall.

4. The method of claim 2, further comprising the step of charging the microchannel to attract the charged droplet.

5. The method of claim 4, wherein the step of charging the microchannel comprises the step of connecting the microchannel to an electrode and a channel charging circuit.

6. The method of claim 4, further comprising the step of charging a neighboring microchannel.

7. The method of claim 6, further comprising the step of charging the neighboring microchannel with a charge opposite that of the microchannel.

8. The method of claim 2, wherein the step of directing comprises the step of charging a target electrode positioned adjacent to the virtual wall to guide the droplet to the virtual wall.

9. A method of filling a microchannel with a liquid, comprising:
forming one or more droplets of the liquid; and
directing the droplet towards a fluid interface port formed in a side wall of the microchannel and which communicates with an interior portion thereof such that the droplet traverses the fluid interface port and enters the interior.

10. The method of claim 9, wherein the fluid interface port is a filling aperture.

11. The method of claim 9, further comprising the step of forming a pressure barrier in the microchannel to force the liquid in a first direction.

12. The method of claim 11, further comprising the step of providing a stopper hole in the sidewall of the microchannel to form the pressure barrier.

13. The method of claim 11, further comprising the step of disposing a hydrophobic patch within the interior of the microchannel to form the pressure barrier.

14. The method of claim 9, further comprising the step of providing a vent hole in the sidewall of the microchannel for allowing air to escape therefrom.

15. The method of claim 9, wherein the steps of forming and directing are repeated until the microchannel is filled with the liquid.

16. The method of claim 9, further comprising the step of closing the fluid interface port after the microchannel is filled with the liquid.

17. The method of claim 16, wherein the step of closing comprises:

forming drops of an encapsulant; and

dispensing the drops of the encapsulant onto the fluid interface port to close the fluid interface port.

18. The method of claim 16, wherein the step of closing comprises the step of closing the fluid interface port with a covering layer.

19. The method of claim 18, further comprising the step of adhering the covering layer to the microchannel on top of the fluid interface port.

20. A method of filling a microchannel with a plurality of liquids, comprising:

providing a microchannel comprising a side wall encompassing a hollow interior, a first filling aperture formed in the side wall to provide access to the interior and a second filling aperture formed in the side wall to provide access to the interior;

forming one or more droplets of the first liquid;

directing a droplet of the first liquid towards the first filling aperture in the side wall such that the droplet traverses the filling aperture and enters the interior;

forming one or more droplets of a second liquid;

directing a droplet of the second liquid towards the second filling aperture in the side wall such that the droplet of the second liquid traverses the filling aperture and enters the interior.

21. The method of claim 20, wherein the first liquid and the second liquid are immiscible with each other and do not mix when disposed in the interior of the microchannel.

22. A method of performing a liquid to liquid extraction technique, comprising the steps of:

providing a microchannel having a side wall, an interior chamber, a fluid interface port, and a target liquid disposed in the interior chamber to form a virtual wall in the fluid interface port; and

injecting a source liquid through the virtual wall and into the target liquid to extract a substance from the source liquid.

23. The method of claim 22, further comprising the step of collecting the target liquid after the target liquid extracts the substance from the source liquid.

24. The method of claim 22, further comprising the step of separating the source liquid from the target liquid after the target liquid extracts the substance from the source liquid.

25. The method of claim 22, wherein the source liquid is immiscible with the target liquid.

26. The method of claim 22, wherein the source liquid comprises an organic solvent and the substance comprises a water-soluble substance.

27. The method of claim 22, wherein the target liquid comprises an aqueous solution.

28. The method of claim 22, further comprising the step of ejecting the source liquid from the interior through the virtual wall.

29. A method of processing a liquid, comprising:

providing a microfluidic system comprising a substrate and a microchannel for housing a first fluid formed in the substrate, said microchannel comprising a side wall, an interior, and a plurality of fluid interface ports such that that the first fluid therein forms a virtual wall in each of said plurality of fluid interface ports;

injecting a second liquid into the first liquid in the microchannel through said virtual walls; and

performing a chemical manipulation on the second liquid and the first liquid to form a reacted fluid.

30. The method of claim 29, further comprising the step of ejecting the reacted fluid through the virtual wall.

31. The method of claim 30, wherein the step of ejecting the reacted fluid comprises the step of establishing an electric field to attract the reacted fluid through the virtual wall.

32. The method of claim 31, wherein the step of establishing an electric field comprises the steps of

disposing a first electrode in the microchannel and a second electrode adjacent to one of said virtual walls outside of the microchannel, and

applying a potential difference between the first electrode and the second electrode to form the electric field.

33. The method of claim 29, wherein the step of ejecting the reacted fluid comprises the step of applying a pressure pulse to the reacted fluid.

34. The method of claim 29, wherein the step of ejecting the reacted fluid comprises the step of applying a gas pressure pulse to the reacted fluid.

35. The method of claim 34, wherein the gas pressure pulse is generated by a third virtual wall in the microchannel disposed substantially coaxially with the second virtual wall.

36. The method of claim 29, wherein the step of ejecting the reacted fluid comprises the step of applying heat to the reacted fluid.

37. The method of claim 29, further comprising the step of detecting the reacted fluid.

38. The method of claim 37, wherein the step of detecting comprises the step of focusing a light beam with an optical element, said light beam impinging upon the fluid in the microchannel through the virtual wall.

39. The method of claim 29, further comprising the step of injecting a third liquid into the microchannel through one of said virtual walls.

40. The method of claim 29, wherein the chemical manipulation comprises a reaction on an analyte.

41. The method of claim 40, wherein the chemical manipulation comprises a labeling operation.

42. A method of introducing a second liquid into a microchannel filled with a first fluid, said method comprising:

forming a droplet from the second liquid,

introducing said droplet through a virtual wall formed by the first fluid in a fluid interface port formed in a sidewall of the microchannel.

43. The method of claim 42, wherein the microchannel further comprises a second fluid interface port, formed in the sidewall, disposed opposite to the fluid interface port and arranged coaxially therewith.

44. The method of claim 42, further comprising the step of employing the virtual wall as an optical window for optically detecting one of the fluids in the microchannel.

45. The method of claim 44, further comprising the step of optically detecting the fluid in the microchannel through the virtual wall formed in the fluid interface port.

46. The method of claim 42, wherein the dead volume of the fluid interface port is less than about a nanoliter.

47. The method of claim 42, wherein the fluid interface port has zero dead volume.

48. The method of claim 42, wherein the step of introducing the droplet comprises the step of introducing the droplet into the virtual wall at a speed and a direction such that the droplet traverses the virtual wall.

49. The method of claim 42, further comprising the step of charging the droplet to form a charged droplet.

50. The method of claim 49, further comprising the step of generating an electric field to guide the charged droplet towards the virtual wall.

51. The method of claim 49, further comprising the step of deflecting the charged droplet with at least one electrically controlled deflection plate.

52. The method of claim 42, further comprising a plurality of fluid interface ports formed in said sidewall, the method further comprising the steps of
charging the droplet to form a charged droplet,
charging the microchannel, and
selecting one of said plurality of fluid interface ports to introduce the charged droplet.

53. The method of claim 42, further comprising a plurality of microchannels having one or more fluid interface ports, the method further comprising the steps of
charging the droplet to form a charged droplet,
charging one or more of the plurality of microchannels, and
selecting at least one of said channels to introduce the charged droplet.

54. The method of claim 53, further comprising the step of selecting at least one of said fluid interface ports of one of said plurality of microchannels to introduce the charged droplet.

55. The method of claim 42, wherein the droplet is immiscible with the first liquid.

56. The method of claim 42, further comprising the step of moving the fluid in the microchannel.

57. The method of claim 56, wherein the step of moving the fluid comprises applying an electric field to the first fluid to move the fluid within the microchannel.

58. The method of claim 42, wherein the droplet has a diameter that is smaller than the fluid interface port.

59. The method of claim 42, further comprising the steps of providing an array of fluid interface ports and forming the droplet to have a diameter that is substantially larger than one of said array of fluid interface ports.

60. The method of claim 59, further comprising the step of introducing the droplet to said array of fluid interface ports.

61. The method of claim 42, further comprising the step of forming the droplet on a droplet carrying element.

62. The method of claim 61, wherein the step of introducing comprises the step of applying the droplet to the virtual wall with the droplet carrying element.

63. The method of claim 42, further comprising the steps of:

forming a second droplet from a third liquid; and

injecting the second droplet through a second virtual wall formed in a second fluid interface port formed in the microchannel.

64. A method of injecting a second liquid into a microchannel filled with a first fluid, said method comprising:

forming a droplet from the second liquid,

introducing said droplet through a virtual wall formed by the first fluid in a fluid interface port formed in a sidewall of the microchannel, said fluid interface port having a diameter between about 25 μm and about 100 μm.

65. A method of injecting a second liquid into a microchannel filled with a first fluid, said method comprising:

forming a droplet from the second liquid,

introducing said droplet through a virtual wall formed by the first fluid in a first fluid interface port formed in a sidewall of the microchannel, wherein the microchannel is free of a second coaxially arranged fluid interface port formed in the sidewall at a location opposite to the first fluid interface port.

66. A method of injecting a second liquid into a microchannel filled with a first fluid, said method comprising:

forming a droplet from the second liquid,

introducing said droplet through a virtual wall formed by the first fluid in a first fluid interface port formed in a sidewall of the microchannel, wherein the fluid interface port has a dead volume that is less than about one nanoliter.

67. A method of separating a sample into different components according to size, comprising

providing a microchannel having an interior bounded by a side wall, a fluid interface port formed in the side wall of the microchannel to provide access to the interior of the microchannel, and a fluid washing medium disposed in the interior of the microchannel and forming a virtual wall at the fluid interface port,

inducing a flow in the washing medium,

forming a droplet of the sample,

injecting the droplet through the virtual wall into the flowing washing medium, such that the components of the sample separate by diffusion into the washing medium at different diffusion rates and wherein the diffusion rate of a component is determined by particle size.

68. The method of claim 67, further comprising the step of collecting the diffused components.

69. The method of claim 67, wherein the sample comprises DNA and contaminants and the step of injecting the droplet of the sample into the washing medium purifies the DNA by separating the contaminants from the DNA.